DOCUMENT RESUME

ED 382 453 SE 055 888

AUTHOR Harding, R. Frederick; Fletcher, Richard K., Jr.
TITLE Effectiveness of Variations in Collaborative Cooperative Learning in RDS Mathematics Classes.
PUB DATE 18 Nov 94
NOTE 18p.; Paper presented at the Annual Meeting of the Tennessee Academy of Science (Nashville, TN, November 18, 1994).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Ability Grouping; *Algebra; *College Students; *Cooperative Learning; Developmental Programs; *Grouping (Instructional Purposes); Higher Education; Mathematics Achievement; Mathematics Instruction; *Remedial Instruction

ABSTRACT

Alarming questions are being asked of the teaching methods in present use. Are we maximizing the time on task in the classroom? Students (n=98) in a remedial mathematics course were studied for one semester and students (n=56) from a developmental mathematics course were studied in the second semester, at Tennessee Technological University. Students were divided into four different groups--traditional cooperative learning, ability aligned cooperative learning, alphabetical cooperative learning, and a non-cooperative learning control group. Each of the groups was pretested with the AAPP test for mathematics and posttested with the same instrument at the end of the semester. Though results did not indicate statistically significant differences favoring the cooperative learning groups over the non-cooperative control group, the greatest gains were by the traditional cooperative groups. The other cooperative learning groups did not gain appreciably differently from the non-cooperative groups. (Contains 54 references.) (MKR)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED 382 453

EFFECTIVENESS OF VARIATIONS IN COLLABORATIVE COOPERATIVE LEARNING IN RDS MATHEMATICS CLASSES

R. Frederick Harding

White County High School

and

Richard K. Fletcher, Jr.

Tennessee Technological University

A Paper Presented at the Annual Meeting
of the Tennessee Academy of Science

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

RICHARD K. FLETCHER, Jr.

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Nashville, Tennessee

November 18, 1994

BEST COPY AVAILABLE

SE055888

Abstract

This study was conducted over two semesters at Tennessee Technological University. Students in a remedial mathematics course were studied for the first semester and students from a developmental mathematics course were used in the second semester. Students were divided into four different groups - traditional cooperative learning, ability aligned cooperative learning, alphabetical cooperative learning, and a non-cooperative control group. Each of the groups were pretested with the AAPP test for mathematics and post-tested with the same instrument at the end of the semester. Though results did not indicate statistically significant differences favoring the cooperative learning groups over the non-cooperative control group, the greatest gains were by the regular cooperative groups (STAD). The other cooperative learning groups did not gain appreciably different from the non-cooperative groups.

INTRODUCTION

Alarming questions are being asked of the teaching methods in present use. Are we maximizing the time on task in the classroom (Kelly, 1993)? In USA Today "U.S. Pupils Rank Low in Global Tests", Dennis Kelly says "We're about on a level with Spain and somewhat below Slovenia". The conclusion of all but the newest International comparison of student's abilities in mathematics and science is clear. U.S. Kids still ranked at the bottom. Despite a decade of education reform, this nation is losing its competitive edge with poorly educated students. Kelly continues, "American kids appear to like math, the trouble is they can't do it" as 69.5 percent of freshmen-entering Board of Regents colleges and universities this fall ended in at least one remedial developmental course. According to data students at two- year colleges and those 21 and older are much more likely to need remedial courses. Among first-time freshmen, 48.7 percent of those at a university required at least one such course compared to 83.6 percent at two-year institutions. System wide, 94.6 percent of first-time freshmen age 21 and older need remediation compared to 61.5 percent of those 20 and under. In the eight years since the R/D program was begun, mathematics has remained the area in which the greatest percentage of entering students need additional preparation (Pride, 1992).

A 1992 Exxon Research Project by the Kellogg Institute was one of the most complete in-depth studies ever conducted of developmental education in the United States. This study reports that 3.5 million students nationwide are in Developmental Education. This amounts to 40-50% of all students. 6000 students were in the study, with 2000 variables. The conclusion was that bad programs seem to cost about the same as good programs.

The curriculum area most often offered was math. The goal of Developmental Education is to reduce differences between strongest and weakest students. Learning strategies should be emphasized, not just for developmental learners, but for all students. Tutorial programs have significant impact when combined with tutor training advising/counseling had positive impact components with most impact: Centralization, tutorial services with training and evaluation, and program-wide evaluation.

The National Research Council has estimated that 75 percent of the nation's high school graduates are so poorly trained that they would flunk out of a beginning college freshman math or engineering course. The result is a massive shortage of American scientists, mathematicians, and

engineers. Inadequacies in precollege math and science education are a chronic and serious threat to our nation's future. The national interest is strongly bound up in the ability of America to compete technically. A study last year by the Council of Chief State School Officers showed that less than half of American high school graduates have taken chemistry and algebra II, both of which are considered crucial preparation for college work in math and science.

Milton Goldberg, a Director of Research for the Dept. of Education said, "For years science and math educators have espoused hands-on learning. However student experiments and hands-on assignments (cooperative learning experiences) have actually declined in recent years. Students spend more time in lectures or reading..than participating. Time spent in laboratory work is declining." Math textbooks that dominate the curriculum are outdated and inadequate (Fisher, 1992). Inadequacies in precollege math and science education are a chronic and serious threat to our nation's future. The national interest is strongly bound up in the ability of American to compete technically.

Shirley A. Hill, says "There has been a long time consensus about making mathematics-learning more about thinking and engaging the intellect and less about memorizing: more a task for the mind than a test of rote memory. That basic philosophy is now manifested in detailed and specific terms in a document that is the centerpiece of the profession's reform in mathematics" (Fisher, 1992). The common and possibly the worst way to teach is the traditional lecture. Teachers should explore the cooperative learning methods to more efficiently teach.

Simply placing students in groups and teaching them to work together does not in and of itself promote higher achievement and higher-level reasoning. There are many ways in which group efforts may go wrong (Johnson & Johnson, 1989). In order to be productive, cooperative learning groups must be structured to include the essential elements of positive interdependence (each member can succeed only if other members succeed), face-to-face interaction during which students assist and support each other's efforts to achieve, individual accountability to ensure that all the members do their fair share of the work.

You learn math by doing. Coaches can not tell a player how to do something, and then never require practice and expect his players to do well. The same holds true for mathematics. The "telling how to" is not as important as the "practicing how to".

Learning consists of evaluating new information in relation to information that's already

understood and storing it in a form that's available for use in new situations. Learning is most effective when one person is teaching one other person (one-to-one learning).

Weissglass concludes that one of the main difficulties in using a small group cooperative learning approach is that students must take responsibility (Wiesglass, 1992).

According to Glasser, teachers are concerned about losing power and control. They will wonder if students can be trusted to work together. Socrates thought students were lazy and did not pay attention. But as real concrete answers to these questions exit, neither are there real concrete answers to the lecture classroom (Glasser, 1986).

It takes time and practice for teachers and students to learn the skills required of the collaborative strategies. Research show that students not only learn the academic content, but also develop and employ higher-level thinking skills. They develop greater appreciation of group members and learn to apply social skills in groups beyond the classroom.

92% of developmental college students relate vivid memories of being embarrassed or humiliated by a teacher in a mathematics class during their precollege schooling. The teacher can no longer be the source of knowledge but a facilitator in the learning process. Students must learn to question and be questioned without fear of being admonished for not "knowing" mathematics (Koch, 1980). William Glasser says, "teacher's can't make students learn, but they can certainly set things up so that students want to learn". We tend to do the opposite; using poor grades as a handicap, we put more weight on the poor students and give more opportunities to the good ones.

There is no doubt that knowledge is power, but U.S. schools aren't getting the message across. In control-theory schools, discipline problems will disappear, the number of teenage pregnancies will drop, drug use will diminish - because all of these are self destructive ways for young people to gain the sense of power and importance that they aren't finding today in their class rooms. Keep in mind, though, that students whose needs are satisfied learn more and cost less (Gough, 1987).

The use of cooperative learning is consistent with the suggestion in the NCTM's (1989) Curriculum and Evaluation Standards that instruction rely less on the teacher and more on small-group learning. Usually five or six weeks is required for such results, unless the students have previously had cooperative learning experiences. (N.C.T.M., 1989)

Five elements to note about collaborative learning are: first, positive interdependence where

the teachers care about each other's productivity and well-being; second, a lot of face-to-face interaction among the teachers who talk to each other about professional practices; third, individual accountability seen as no freeloading or hitchhiking; fourth, the teachers have the social skills, the leadership, the group decision making, the conflict management skills they need in order to operate together; and fifth, the teams review their effectiveness (Johnson & Johnson 1987).

Cooperative learning may be contrasted with competitive and individualistic learning. In a competitive learning situation, students work against each other to achieve a goal that only one or a few students can attain. Students are graded on a curve, which requires them to work faster and more accurately than their peers. Thus, students seek an outcome that is personally beneficial but detrimental to all other students in the class in an individualistic learning situation, students work by themselves to accomplish learning goals unrelated to those of the other student. Individual goals are assigned, students' efforts are a fixed set of standards and students are rewarded accordingly. Thus, the student outcome that is personally beneficial and ignores as irrelevant the goal achiever students (Johnson & Johnson, 1989).

Working cooperatively can have profound effects on students (Johnson & Johnson, 1989). During the past 9 years over 60 studies have been conducted. Cooperative learning experiences promote higher achievement than do competitive and individualistic learning (effect sizes of 0.66 and 0.63 respectively). In addition to the mastery and retention of material being studied, achievement is indicated by the quality of reasoning strategies used to complete the assignment, the generation of new ideas and solutions (i.e., process gain), and the transfer of what is learned within one situation to another (i.e., group-to-individual transfer). The more conceptual the task, the more problem solving required, the more desirable higher-level reasoning and critical thinking, the more creative the answers needed, the more long-term retention desired, and the greater the application required of what is learned, the greater the superiority of cooperative over competitive and individualistic learning.

Many of the studies relating cooperative learning experiences and achievement have focused on quality of reasoning strategy, level of cognitive reasoning strategy, level of cognitive reasoning, and metacognitive strategies (Johnson & Johnson, 1989). In studies on tasks that could be solved using reasoning strategies, a more frequent discovery and use of the higher-level reasoning strategies occurred more within the cooperative than within competitive or individualistic

teaming situation (Gabbert, Johnson & Johnson, 1985).

STATEMENT OF PROBLEM

Developmental Studies students often come to us from widely differing school backgrounds and performances. Not only with weak skills, but they also come with negative attitudes that harbor the lack of skills and thought processes necessary for the general curriculum. RDS Faculty are expected to prepare students for college course work to the level that was expected of college bound (traditional) students leaving Senior High School. As educators attempt to meet the global challenges of a world competition and prepare our students for the future, methods of enhancing and extending our efficiency of teaching focuses attention on collaborative learning.

The purpose of this study was to compare collaborative learning versus non cooperative settings in several Remedial Developmental Mathematics classes at T.T.U. as methods are being explored to better prepare weak performing math students for 100 and 200 level math classes, every alternative should be investigated. Eleven variables were investigated which included performance differences by sex, cooperative learning versus noncooperative learning methods, and various types of cooperative learning methods. Each of the comparisons were on scores on the pretest, posttest, and difftest(gains from pre-to-posttest). Two courses were used in the investigation, Beginning Algebra (RDS083) and Prealgebra (RDS073).

RESEARCH METHODOLOGY FOLLOWED

This study was carried out for two semesters with basically all of the RDS073 Prealgebra classes and several RDS083 Beginning Algebra classes. Peer tutoring groups were organized by standard COOP procedures(STAD), alphabetically, ability aligned, and all lecture type.

The AAPP standardized posttest were administered by qualified counselors skilled in this procedure. The AAPP Pretest used was the score made when the student initially entered the RDS program. A posttest was given at the end of the semester. Pre-to-Posttest difference scores (gains) of each experimental group were compared with the control group.

NULL HYPOTHESIS OR PREDICTION

There will be no statistically significant difference at the 0.05 level between groups on the pretest-posttest gains on the AAPP of each experimental Cooperative Learning group and its corresponding control group.

There will be no statistically significant difference at the 0.05 level between groups on the pretest scores on the AAPP of each experimental Cooperative Learning group and its corresponding control group.

There will be no statistically significant difference at the 0.05 level between groups on the posttest scores on the AAPP of each experimental Cooperative Learning group and its corresponding control group.

There will be no statistically significant difference at the 0.05 level between groups on the pretest-posttest gains on the AAPP when compared by gender of the student.

There will be no statistically significant difference at the 0.05 level between groups on the pretest scores on the AAPP when compared by gender of the student.

There will be no statistically significant difference at the 0.05 level between groups on the posttest scores on the AAPP when compared by gender of the student.

There will be no statistically significant difference at the 0.05 level between groups on the gains on the AAPP in the non-coop learning control group and those in the Cooperative Learning groups.

There will be no statistically significant difference at the 0.05 level between groups on the pretest scores on the AAPP in the non-coop learning control group and those in the Cooperative Learning groups.

There will be no statistically significant difference at the 0.05 level between groups on the posttest scores on the AAPP in the non-coop learning control group and those in the Cooperative Learning groups.

The gains from pre-to-posttest on the AAPP of the various groups will not be statistically significant at the 0.05 level.

ANALYSIS OF DATA AND PRESENTATION OF FINDINGS

This study concentrated on measuring differences in achievement among Tennessee Technological University developmental students. A comparison was made between classes utilizing various cooperative learning strategies and classes being instructed in a traditional strategy.

Using an AAPP math achievement examination, pretest scores were compared with posttest scores of 154 Prealgebra (RDS073) and beginning algebra (RDS083) students at Tennessee Tech.

Study was conducted with 98 students in RDS073 in Fall 1991 and with 56 students in RDS083 in Spring 1992. 57 males in this study made up 37% of the total study. 97 females made up the remaining 63 % of the group tested.

The separate learning groups varied as follows:

1 (35 OBSERVATIONS)	"NORMAL" (STAD) COOP GROUP	22.7% of total
2 (19 OBSERVATIONS)	ABILITY ALIGNED COOP GROUP	12.3% of total
4 (21 OBSERVATIONS)	ALPHABETICAL COOP GROUP	13.6% of total
5 (79 OBSERVATIONS)	NON-COOP CONTROL GROUP	51.3% of total

SEPARATE MATH 073 SECTIONS IN FALL91 (98 TOTAL OBSERVATIONS)

1 (20 OBSERVATIONS)	"NORMAL" STAD COOP GROUP	13.0% of total
2 (19 OBSERVATIONS)	ABILITY ALIGNED GROUP	12.3% of total
4 (21 OBSERVATIONS)	ALPHABETICAL COOP GROUP	13.6% of total
5 (38 OBSERVATIONS)	NON-COOP CONTROL GROUP	24.7% of total

SEPARATE MATH 083 ONLY SECTIONS IN SPRING91 (56 TOTAL OBSERVATIONS)

1 (15 OBSERVATIONS)	"NORMAL" STAD COOP GROUP	9.7% of total
5 (41 OBSERVATIONS)	NON-COOP CONTROL GROUP	11.7% of total

Table I contains the results from an analysis of variance comparing scores of male and female students on the Pretest, Posttest, and Difftest for students in both RDS073 and RDS083.

TABLE I

COMPARISON OF THE MEANS OF
FEMALE AND MALE STUDENTS IN RDS073 AND RDS084
REMEDIAL AND DEVELOPMENTAL MATHEMATICS

COURSE	DEP.VAR.	MEANS		F-RATIO	SIGN. LEVEL
		MALE	FEMALE		
RDS073	PRETEST	21.16	19.00	6.17	0.0147
RDS073	POSTTEST	28.28	26.26	2.97	0.0881
RDS073	DIFFTEST	7.13	7.26	0.01	0.9064
RDS083	PRETEST	22.28	20.90	1.11	0.2959
RDS083	POSTTEST	24.08	24.19	0.01	0.9336
RDS083	DIFFTEST	1.80	3.29	1.03	0.3145

The only statistically significant differences (0.05) was on the Pretest scores for students in RDS073. Male students outperformed female students with a mean of 21.16 versus 19.00 on the AAPP test.

Though the Posttest scores were not statistically significant the trend continued favoring the male students. The probability level was 0.0881 slightly above the 0.05 level. The gain scores for the two two groups were almost equal, 7.13 versus 7.26. None of the comparisons relating to students in RDS083 were close to being statistically significant though female students outgained their male counterparts 3.29 to 1.80 points.

Table II contains the results from an analysis of variance comparing scores of students enrolled in cooperative learning classes and students enrolled in traditional lecture courses on the Pretest, Posttest, and Difftest for students in both RDS073 and RDS083. No statistically significant differences (0.05) were found on any of the comparisons. However students in RDS083 cooperative learning classes outperformed students in the traditional sections of the same course with a mean of 25.40 versus 23.68 on the AAPP test. Though the Posttest scores were not statistically significant the trend existed favoring the cooperative learning students. The probability level was 0.2592 above the 0.05 level. The gain scores for the two groups in RDS083 were quite different, 4.07 versus 2.10. None of the comparisons relating to students in RDS073 were close to being statistically significant with the gains for the two groups being 7.28 and 7.11.

TABLE II

COMPARISON OF THE MEANS OF STUDENTS IN RDS073 AND RDS084
REMEDIAL AND DEVELOPMENTAL MATHEMATICS COURSES
BY METHOD OF INSTRUCTION - COOP. VS NONCOOP. LEARNING

COURSE	DEP.VAR.	MEANS		F-RATIO	SIGN. LEVEL
		COOP.LRN	NONCOOP.		
RDS073	PRETEST	20.07	19.13	1.19	0.2776
RDS073	POSTTEST	27.35	26.24	0.95	0.3321
RDS073	DIFFTEST	7.28	7.11	0.03	0.8697
RDS083	PRETEST	21.33	21.59	0.03	0.8653
RDS083	POSTTEST	25.40	23.68	1.30	0.2592
RDS083	DIFFTEST	4.07	2.10	1.44	0.2356

TABLE III

COMPARISON OF THE MEANS OF STUDENTS IN RDS073 AND RDS084
REMEDIAL AND DEVELOPMENTAL MATHEMATICS COURSES
BY CLASSIFICATION OF INSTRUCTION METHOD

COURSE	DEP.VAR.	MEANS				F-RATIO	SIGN. LEVEL
		NORCOOP	ABLCOOP	ABCCOOP	CONTROL		
RDS073	PRETEST	20.20	19.58	20.38	19.13	0.52	0.6667
RDS073	POSTTEST	29.45	25.68	26.86	26.24	1.98	0.1222
RDS073	DIFFTEST	9.25	6.11	6.48	7.11	1.48	0.2249

The results depicted in TABLE III show the comparisons according to the particular subgroup where the student was enrolled. These groups included the three cooperative learning groups and the control group. These variations were available only for students in RDS073 courses. Though no statistically significant differences (0.05) were found across the subgroups on the Posttest scores there was considerable variation in the means ranging from a high for the normal STAD cooperative learning group of 29.45 to a low on the ability grouped cooperative learning subgroup of 25.68. The significance level of 0.1222 was beyond the 0.05 level hence no statistical significance was determined to exist.

TABLE IV

SIGNIFICANCE OF GAINS FROM PRETEST TO POSTTEST USING
THE CORRELATIONAL T-TEST PROCEDURE FOR STUDENTS IN
REMEDIAL AND DEVELOPMENTAL MATHEMATICS

COURSE	GAIN IN MEANS	T-TEST	SIGN.LEV
RDS073	7.21	13.75	0.0001
RDS083	2.63	3.60	0.0007
RDS073COOP.LRN	7.28	10.35	0.0001
RDS073NONCOOP.LRN	7.11	9.07	0.0001
RDS083COOP.LRN	4.07	6.05	0.0001
RDS083NONCOOP.LRN	2.10	2.19	0.0344

Results shown in TABLE IV reflect the amount and statistical significance of growth or gains from the Pretest to the Posttest for the various subgroups. The correlated t-test indicates that

statistical significance at the 0.05 level is realized for each of the subgroups with the significance level of 0.001 or beyond being evident for all except the traditional group in RDS083.

SUMMARY AND CONCLUSIONS

This study produced few areas where statistical differences occurred other than in the gains from pre-to-posttest. Every group gained significantly as a result of the learning experience. When comparisons between groups were made by sex and by cooperative versus traditional methods there were no statistically significant results. However, there were trends favoring the students in some of the cooperative learning groups, especially the normal STAD cooperative learning group. Also, there were trends that favored the gains for the female students over the male students.

It is recommended that further study be completed with greater effort being made to control the sampling process and the variations in teaching methods. If the trend in RDS083 stands up with a larger sample it would possibly produce statistically significant differences favoring the cooperative learning group.

Problems associated with this study include time limitations of 4 class contact hours combined with a high volume of challenging material, only 15 math 083 students is a very low number in the sample size to observe. These time constraints could be addressed in future studies. It is possible that the base line of both control groups was greatly affected by this causing variations in these groups. It appears that the more complicated the math, the more time is needed to properly implement cooperative learning.

There are many reasons for conducting comparisons such as this using cooperative learning methods. Following is a discussion of the many results one may be achieving when employing cooperative learning strategies, whether these were accomplished or not is not known from this investigation other than from a very qualitative form of feedback. The statistical methods employed did not measure the impact on the students of many of these factors.

Collaborative Strategies provide a way to structure student groups for learning. Some of the roles and motivation of cooperative learning are positive interdependence, verbal interaction, individual accountability, and social skills. Within cooperative learning groups there is a process

of interpersonal exchange that promotes the use of higher-level thinking strategies, higher-level reasoning, and metacognitive strategies. Students working together cooperatively expect to teach what they learn to group mates. They do in fact engage in a discussion that often includes the explaining and elaborating of what is being learned.

When the group is heterogeneous, they are exposed to diverse perspectives and ideas. The cooperative context promotes their taking each other's perspectives. While they work together, they monitor each other's participation and contributions and give each other feedback about their ideas and reasoning. Finally, within cooperative groups intellectual conflict often occurs, especially if controversies are deliberately structured by the teachers. To promote higher-level reasoning, critical thinking, and metacognitive skills, teachers are well advised to first establish cooperative learning and then structure academic controversies.

Cooperation is working together to accomplish shared goals and cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning. Within cooperative learning groups students are given two responsibilities: to learn the assigned material and to make sure that all other members of their group do likewise. Their success is measured on a fixed set of standards. Thus, a student seeks an outcome that is beneficial to him- or herself and beneficial to all other group members. The effectiveness of cooperative learning depends on successful team building and indoctrination in social skills.

BIBLIOGRAPHY

(Please note that this bibliography includes numerous other sources not cited in the abbreviated introduction to the paper.)

Annis, L. (1979) The Processes and Effects of Peer Tutoring. Human Learning, 39-47.

Bargh, J., & Schul, Y. (1980) On the Cognitive Benefits of Teaching. Journal of Educational Psychology, 593-604.

Batey, Terry. (1992, Oct) Schools Cheer on Team Teaching.The Tennessean, Sec.B,1,col.2.

Bauersfeld, H. (1980) Hidden Dimensions in the So-called Reality of the Mathematics Classroom. Educational Studies in Mathematics,11, 23-41.

Carton, Kitty. (1990) Sharing Teaching Ideas. Mathematics Teacher, 542-546.

Chiu, Lian-Hwang.(1979, April) Reading Preferences of Fourth Grade Children Related to Sex and Reading Ability. The Journal of Educational Research, Vol 66, No.8, 369-373.

Costa, Art L., Dee Dishon, and Pat Wilson O'Leary. (1992). Collaborative Strategies. Developing Minds: A Resource Book for Teaching Thinking, 77-78.

Dees, Roberta L. (1991, Nov.). The Role of Cooperative Learning in Increasing Problem-Solving Ability in a College Remedial Course. Journal for Research in Mathematics Education, Vol 22 No.5, 409-421.

Dishon, D., and P. A. 0'Learn. (1984). Guidebook for Cooperative Learning: A Technique for Creating More Effective Schools. Holmes Beach, Florida: Learning Publications, 10-11.

Edwards, Jeannie. (1992, November). Collaboration: In Sync or Out of Tune with Cognitive and Ethical Development? Paper: Developmental Composition, Memphis State University, Tn.

Fisher, Arthur. (1992, August). Science + Math = F (Crisis in Education Part 1). Popular Science Magazine. 58-63, 108.

Fisher, Arthur. (1992, September). Why Johnny Can't Do Science and Math (Crisis in Education Part 2). Popular Science Magazine. 50-55,98.

Fisher, Arthur. (1992, October). Edutech (Crisis in Education, Part 3), Popular Science Magazine, 68-71, 94.

Floyd, Cynthis. (1989). America Faces a Choice: Work Smarter, Work Cheaper. Educational Reform: A Tennessee State of Mind

Fuller, Cheri Heath. (1988, September). Discovering Your Child's Learning Style. Focus on the Family, 12-13.

Gabbert, B., David W. Johnson, & Roger T. Johnson. (1986). Cooperative Learning, Group-to-individual Transfer, Process Gain, and the Acquisition of Cognitive Reasoning Strategies. Journal of Psychology, 265-278.

Garland, Mary.(1993, Spring). The Mathematics Workshop Model: AN Interview with Uri Treisman. Journal of Developmental Education Vol 16, No.3, 14-22.

Gough, Pauline B.(1987, May). Cooperative Learning-The Key to Improving Schools: An Interview with William Glasser. Phi Delta Kappan. 656-662.

Gourgey, Annette F. (1993, Spring). Tutoring Developmental Mathematics: Overcoming Anxiety and Fostering Independent Learning. Journal of Developmental Education Vol 15,No.3 10-14.

Jacob, Evelyn, and Beverly Mattson. (September 1987) Cooperative Learning with Limited-English-Proficient Students. ERIC Document Reproduction Service No. ED 287 314.

Johnson, David W. (1971). Role Reversal: A Summary and Review of the Research. International Journal of Group Tensions, 318-334.

Johnson, David W., Johnson, Roger T. (1987). Creative Conflict.Edina, Minnesota: Interaction Book Company.

Johnson,David, and Roger Johnson. (1987, November). On Cooperation in Schools: A Conversation with David and Roger Johnson." Educational Leadership. 14-19.

Johnson, David W., Johnson, Roger T.(1989, October). Collaboration and Cognition. Developing Minds: A Resource Book For Teaching Thinking, 1-9.

Johnson, Roger T., Johnson, David W., and Smith, Karl A. (1990, Winter). Cooperative Learning: An Active Learning Strategy for the College Classroom." Baylor Educator, 11-16.

Johnson, Roger T., David W. Johnson, and P. Roy. (1984). Circles of Learning: Cooperation in the Classroom. Alexandria, Va.: Association for Supervision and Curriculum Development.

Jongsma, Kathleen Stumpf. (1990, January). Questions & Answers - Collaborative Learning. The Reading Teacher, 346-347.

Kanar, Carol C.(1991). The Confident Student. Houghton Mifflin Company, Boston Massachusetts.

Keeverf, Mimi, Kessler, Frank, Faherty, Tory. (1992). Tentative Research: An Update. NADE Newsletter.

Kelly.(1993, (1993, February). U.S. Pupils Rank Low in Global Tests. The Tennessean, section A, p.1.col.3.

Key, Charlene B. (1992, Fall). Cooperative Learning in the DS Math Classroom. Paper: Developmental Math Lab, Middle Tennessee State Univ. Tn.

Key, Charlene B. (1990, Fall). Math Cooperative Learning Equals Success. Paper: Developmental Math Lab, Middle Tennessee State Univ. Tn.

Klausnitzer, Dorren. (1993, February). Children Here are Really Learning, The Tennessean, Sec A, p.1, col. 3.

Koch, Laura Coffin. (1982, Fall). Revisiting Mathematics. Journal of Developmental Education Vol 16,No.1.

Kolb, David A. (1984). Experimental Learning. Englewood Cliffs: Prentice Hall, Inc.

Lowell, Lynn Mclaren, Nexton Inc. (1989, November). RDS Mathematics as a Predictor of College Mathematics. A Paper Presented at the Annual Meeting of the Tennessee Academy of Science Nashville,Tn.

Lively, Kit. (1993, February). States Set up Efforts to End Remedial Courses at 4-Year Colleges. The Chronicle of Higher Education, A28.

McKinney, Richard E. (1976, March). A Mathematical Reading Bibliography. Paper: presented at Tennessee Technological Univ.

Madden, Nancy, Robert Stevens, Robert Slavin, Anna Marie Farnish. (1988, January). Cooperative Integrated Reading and Composition. Paper:Center for Research on Elementary and Middle Schools John Hopkins University .

Miller, Cynthia, Frances J. Grossman, and Brenda D. Smith. (1991, March). The Integration of Reading and Writing in the Teaching of Mathematical Concepts. Paper:presented at NADE Conference.

Murray, F. (1983). Cognitive Benefits of Teaching on the Teacher. Paper presented at American Educational Research Association Annual Meeting, Montreal, Quebec.

Press, Associated. (1993, April). State Students Lag Nation in Math, Science Improvements. Southern Standard, 3 Sec A Col. 1.

Pride, Dana. (1992, December 10). Remedial Class Costs Targeted.Nashville Banner, Sec A pp1.

Rodgers, Cheryl G. (1992, June 30). A Study of Pre to Post Correlates to Academic Achievement in Cooperative Learning at Upperman High School 1991-1992. Paper: Tenn. Tech Univ.

Slavin, R. E. (1987). Cooperative Learning and the Cooperative School. Educational Leadership, 7-13.

Sutton, Gail Oberholtzer. (1992, January). Cooperative Learning Works in Mathematics. Mathematics Teacher Vol 85. No.1, 63-66.

Triesman, Uri "A Model Academic Support System." Math/ Science Workshop Program, Univ of Calif, Berkeley. *1992 ed.

von Glaserfeld, E. (1983). Learning as a Constructive Activity. (Proceedings if the 5th International Conference for the Psychology of Mathematics Education. Montreal,Quebec). Psychology of Mathematics Education.

Monga, Luis, (1992, Spring). Professors Improve Teaching Techniques. Vanderbilt Magazine pp 2.

Weissglass, J. Cooperative Learning Using a Small-Group Laboratory Approach. Unpublished manuscript.

Whimbey, A. & J. Lochhead. (1982). Problem Solving and Comprehension: A Short Course in Analytical Reasoning. Philadelphia: Franklin Institute Press..

Whipple, William R. (October 1987) Collaborative Learning: Recognizing It When We See It. ERIC Document Reproduction Service No. ED 289 396.

Wilson O'Leary, and Dee Dishon. (1990). Cooperative Learning. Developing Minds: A Resource Book for Teaching Thinking.

Wynn, Denise E. (1987, November 20). A Comparison of the Performance of RDS and NONRDS Students in College Mathematics." Paper presented at Annual Meeting of Tenn.. Academy of Science Jackson Community College, Tn.